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SERVICE MANUAL

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# SERVICE MANUAL 283

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B+K PRECISION

# SERVICE MANUAL

## MODEL 283

494-060-9-001

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ADDITIONAL INFORMATION

INCLUDED WITH SERVICE MANUAL: Analyzing Schematics showing positions of FUNCTION & RANGE Switches.

| SCHEMATIC | FUNCTION | RANGE | DRAWING NO. |
|---|---|---|---|
| NO. 1 | DCV | 1V | 496-070-9-001 |
| NO. 2 | ACV | 1000V | 496-070-9-002 |
| NO. 3 | HIGH Ω | 10 MΩ | 496-070-9-003 |
| NO. 4 | LOW Ω | 100Ω | 496-070-9-004 |
| NO. 5 | DCA | 100mA | 496-070-9-005 |
| NO. 6 | ACA | 10mA | 496-070-9-006 |

INCLUDED WITH MODEL 283:

INSTRUCTION MANUAL ..... 480-173-9-001

COMPOSITE ..... 499-086-9-001

## A. CIRCUIT DESCRIPTION

### 1. POWER SUPPLY (fig. 1)

The power supply generates four D.C. voltages with respect to "ground" (foil ground, as opposed to "earth" case ground on 3rd wire of line cord). Most of the secondary current (about 170 mA) comes from the PQR winding through the 43 Ω resistor, devides between Zener D9 and the L.E.D. displays, then returns to center tap Q (the orange wire on transformer). One end of D9 is connected to the circuit through the transformer connector so that, if the battery pack option is used, D9 is in effect removed and wastes no power; in that case, the voltage from "+ 12V" to "V Disp" (V. Display) is regulated by the battery rather than by D9.

The voltage "+ 12V" to ground is tightly regulated by IC2D which is 1/4 of the quad op-amp (type 324). IC2D compares the reference voltage (from high-stability D11) to a fraction of the 12 volts and keeps the two equal by adjusting V Display. This 12V is the most closely controlled of the supply voltages, and results in a constant current (0.5mA) to the reference diode D11.

"-3V" is more loosely controlled by Zener D10, which operates near a relatively "soft" knee. Thus the negative supply line shifts (as much as 0.6 volts) depending on the current through it which is virtually the current drawn by components from +12 to ground (e.g. D11 and IC4, but not IC1 which returns directly to -3).

Note where the circuit is broken to turn the unit off; the transformer is always "hot" and filter capacitors C11 and C12 are always charged. This keeps line voltages off the P.C. board and 120 cycle AC away from the sensitive circuitry.

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POWER SUPPLY

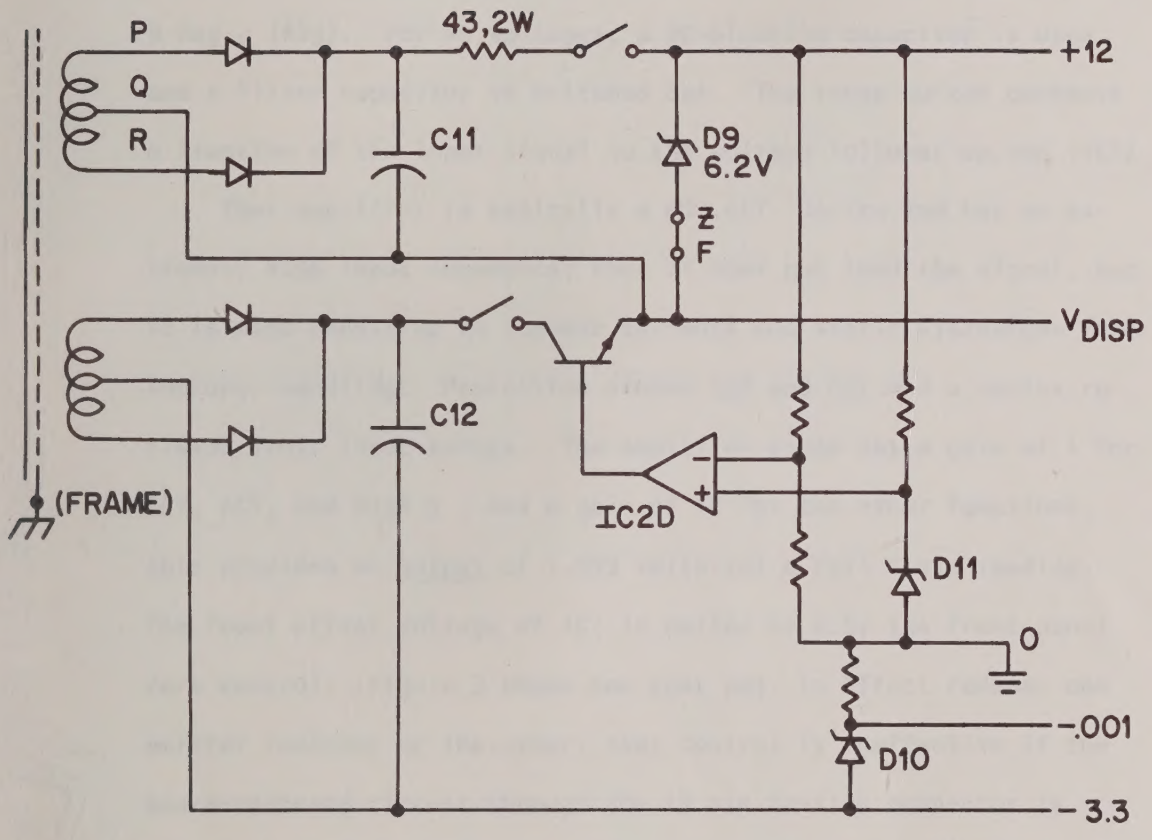
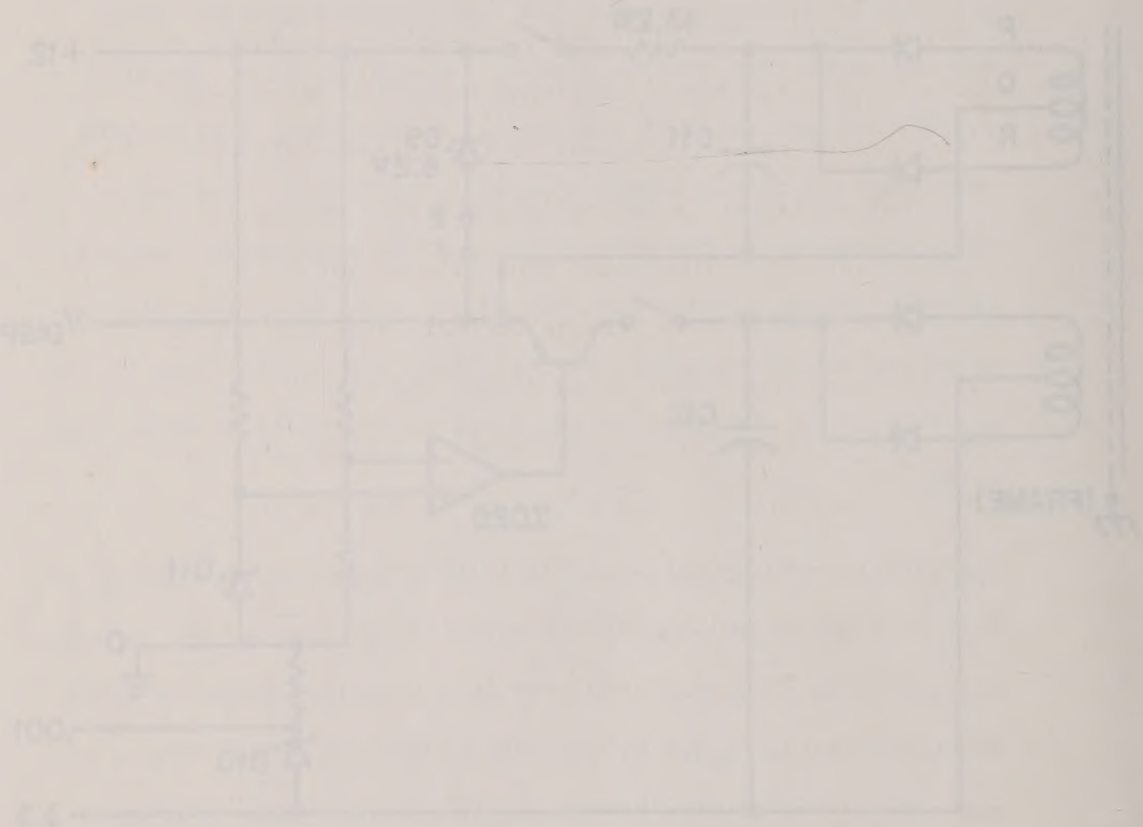



FIGURE 1



2. VOLTAGE ATTENUATOR AND FOLLOWER (fig. 2)

Voltage inputs always see 10 M Ω as they are applied across the divider RN-1. That resistor network is ratio-trimmed so that its smaller resistors are each decade fractions(±1/2%) of the first 9 Meg Ω (R29). For AC voltages, a DC-blocking capacitor is used and a filter capacitor is switched out. The range switch connects a fraction of the input signal to the voltage follower op.amp.(IC1).

That amplifier is basically a MOS.FET. device and has an extremely high input impedance; thus it does not load the signal, but it is also sensitive to leakage currents and static discharges from improper handling. Protection diodes (Q8 and Q9) and a series resistor limit input swings. The amplifier stage has a gain of 1 for DCV, ACV, and High Ω , and a gain of 10 for the other functions; this provides an output of 1.999 volts for a full scale reading. The input offset voltage of IC1 is nulled to 0 by the front panel Zero control. Figure 3 shows how that pot. in effect reduces one emitter resistor or the other; that control is ineffective if the board-to-board circuit through the 15 pin in-line connector is broken. Because of increased gain, the adjustment of the Zero control is 10 times more critical in Low Ω , DCA, & ACA functions than in the others. Note that the supply current for IC1 comes from IC2A.

3. ANALOG-to-DIGITAL CONVERTER (fig. 4)

The basic conversion method is dual-slope integration, with the direction of the ramp depending on the polarity of the input (ohms and AC signals acting as though positive). Figure 4 shows the voltage at the output of the integrator (pin 14 of IC2C) which is also the voltage across C13: that may be viewed by connecting 'scope ground to board-holding bracket(subchassis),

VOLTAGE FOLLOWER

(SHOWN IN 10V. AC POSITION)

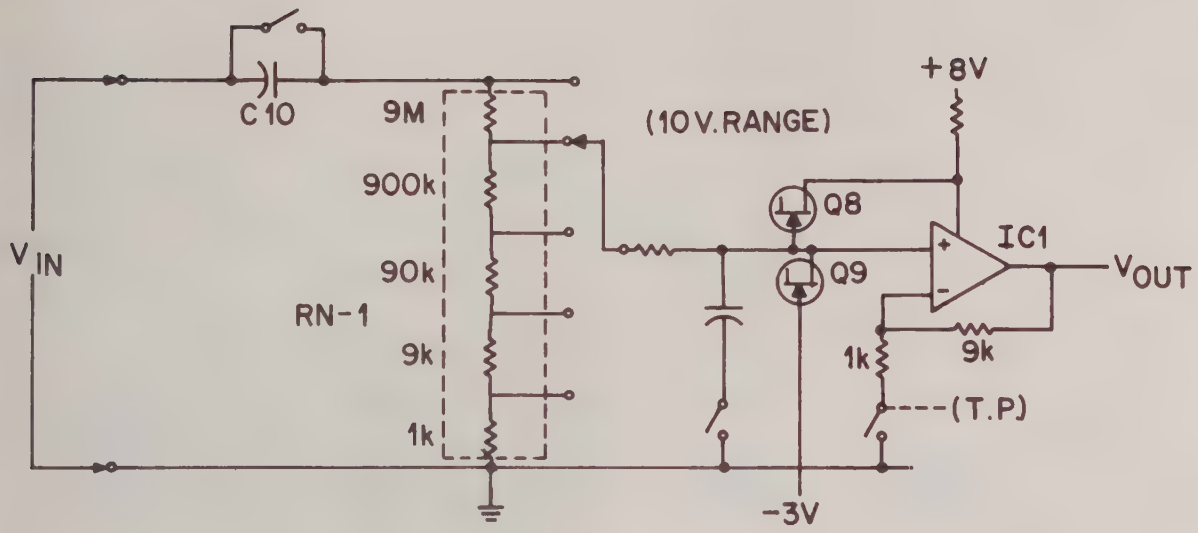



FIGURE 2

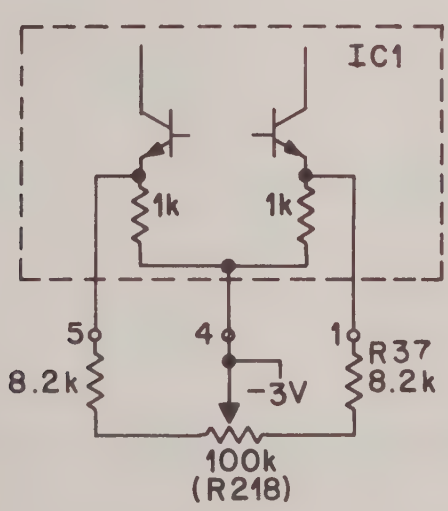



FIGURE 3

ANALOG-TO-DIGITAL CONVERTER WAVEFORMS

(SHOWN FOR POSITIVE INPUT SIGNAL, APPROX. ½ SCALE DISPLAY)

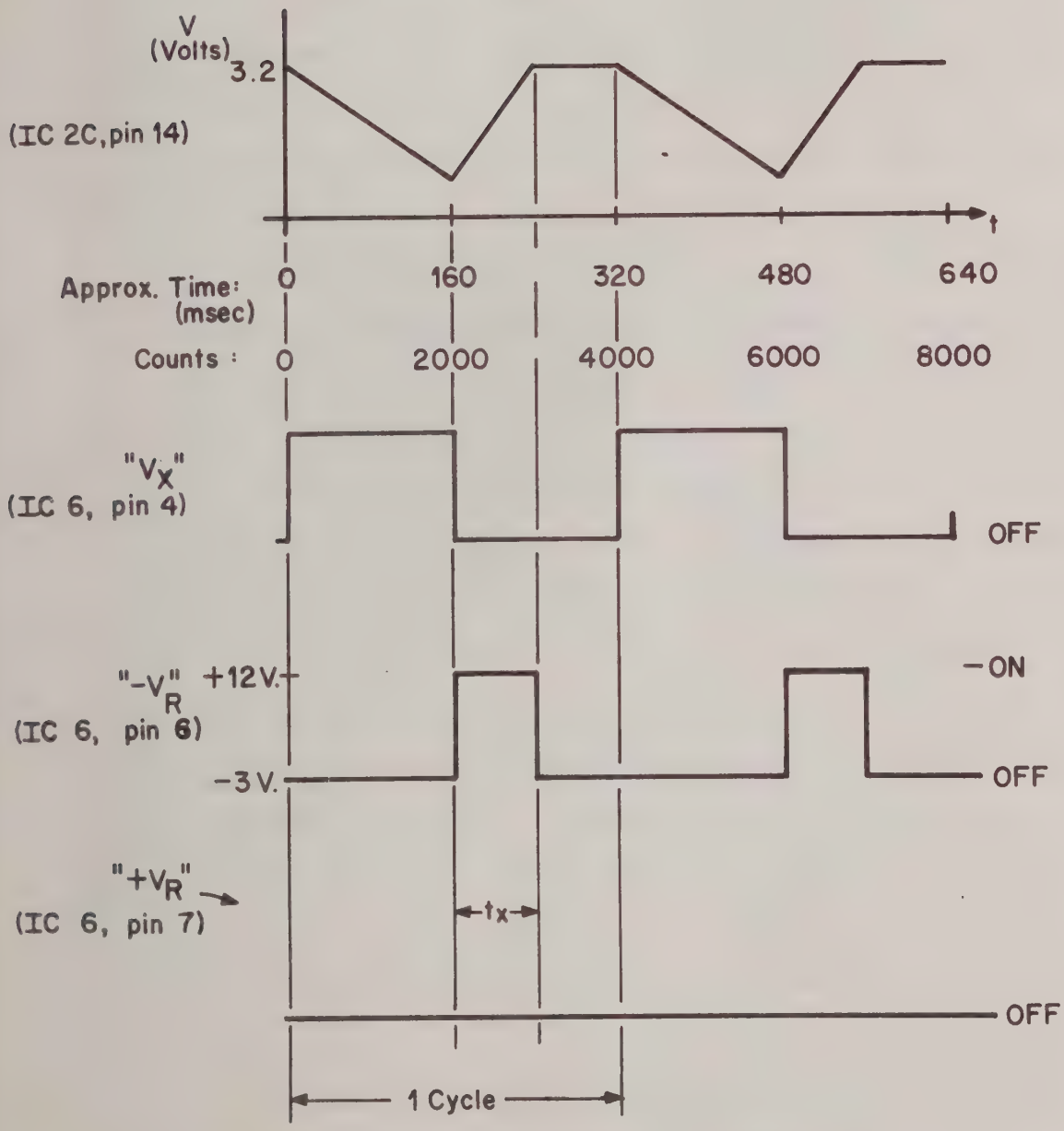



FIGURE 4

probe to C13 (upper lead of large rectangular cap.), and external trigger to R 201 ("$V_x$").

During the first 2000 counts, the capacitor charges with a slope depending on the input to the 283. $\frac{dV}{dt} = \frac{I}{C}$ is the slope; I is developed by the voltage at IC1 pin 6 across R1 (50k) (except in AC), and it goes through switch 1 deck 2 front and FET switch IC8B to op. amp. IC2C pin 13. That input is kept at ground potential by the current through C13 which is the same as the current through R1 since the input draws little current.

On the 2000th count, switch IC8B is turned off and one of the 2 reference currents (set by pots R54 and R55) is switched in to ramp the integrator (IC 2C) back to its starting point of about 3.2V. The counting (of 12 kHz clock pulses) is done by the complex IC6, which also controls the FET switches of IC8 as well as the multiplexing of the display. When the integrator output reaches its starting point, the comparator IC3 switches which tells IC6 to (1) turn off the reference current and (2) store the number of counts since the reference was turned on; this is the number displayed by the LED's. If the input to the 283 is small, the integrator output does not change much and the reference returns it within only a few counts. IC6 decides whether to light the minus sign and which reference to turn on depending on the output of comparator IC3 when the unknown is switched off on the 2000th count.

To maintain a steady "000" display when the input is zero, a brief hold-off is used, set by the values of R217 and C202. During that period, which starts when the unknown current is switched off, the clock driving IC6 (pin 14) is stopped so

1 or 2 counts are lost. This allows the integrator to return from any "noise" drift, but it also introduces a very slight offset so that a meter which is exactly accurate at 1/2 scale will read about one count low at 1/20 scale. If the clock frequency were increased significantly, say by 10% due to replacement of a component of the oscillator circuit of IC7A & B, the number of counts lost in that zero width might increase by one.

4. DISPLAY

The output of the counter and binary-to-7 segment decoder within IC6 controls the LED readout using time multiplexing. The 4 common-anode displays are turned on one at a time by supplying base drive current to each of Q2 through Q5 in sequence. Each digit is on for 2 of the (12 kHz) clock cycles and off for 8 (for 2 of the ten cycles, no digit is on). Except for the Most Significant Digit (MSD = DS-1), the cathodes of the displays are all connected and driven together by energizing the appropriate transistors of IC5 depending on what digit is being displayed at that moment. For the MSD, 2 segments are not connected at all and the center "minus" segment (pin 9) is connected through the function switch on the main PC board so that no polarity sign can flash when reading 000 in ohms or AC functions.

5. AC - to - DC CONVERTER (fig. 5)

When the 283 is set to measure AC voltage, the signal is passed through DC blocking C10 then through the attenuator and follower (IC1) as described above for DC. IC1 and IC4 combine to provide full-wave rectification: when the signal swings positive, the inverting function of IC4 would run its output negative except that its supply is tied very close to zero (this circuit would

AC-TO-DC CONVERTER

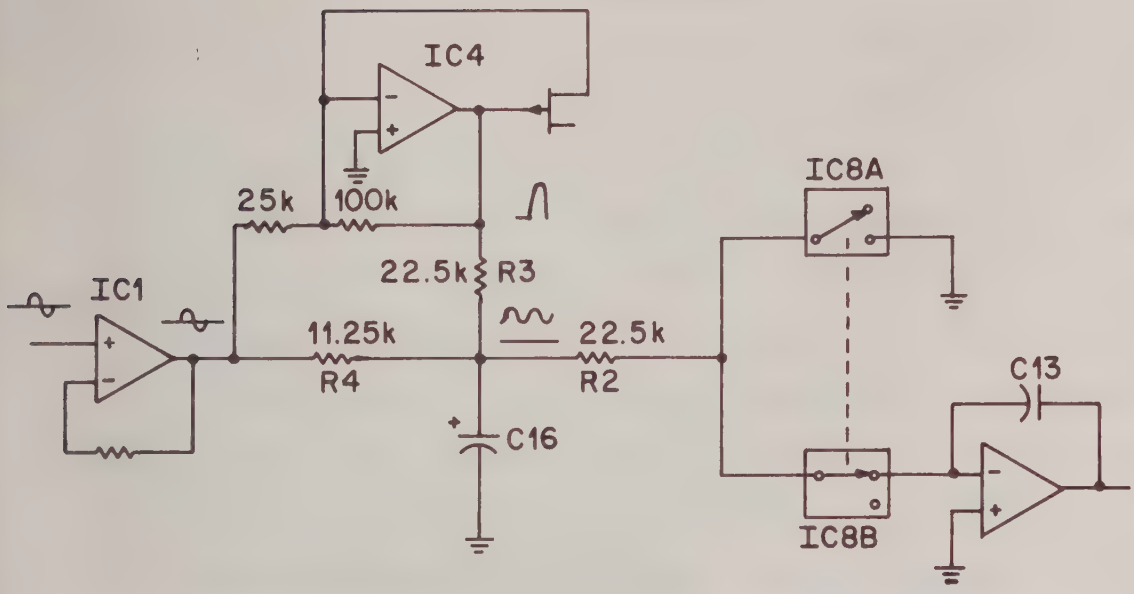



FIGURE 5

OHMS CONVERTER

(SHOWN IN 0.1mA (10K "HIGH Ω" OR "LOW Ω") POSITION)

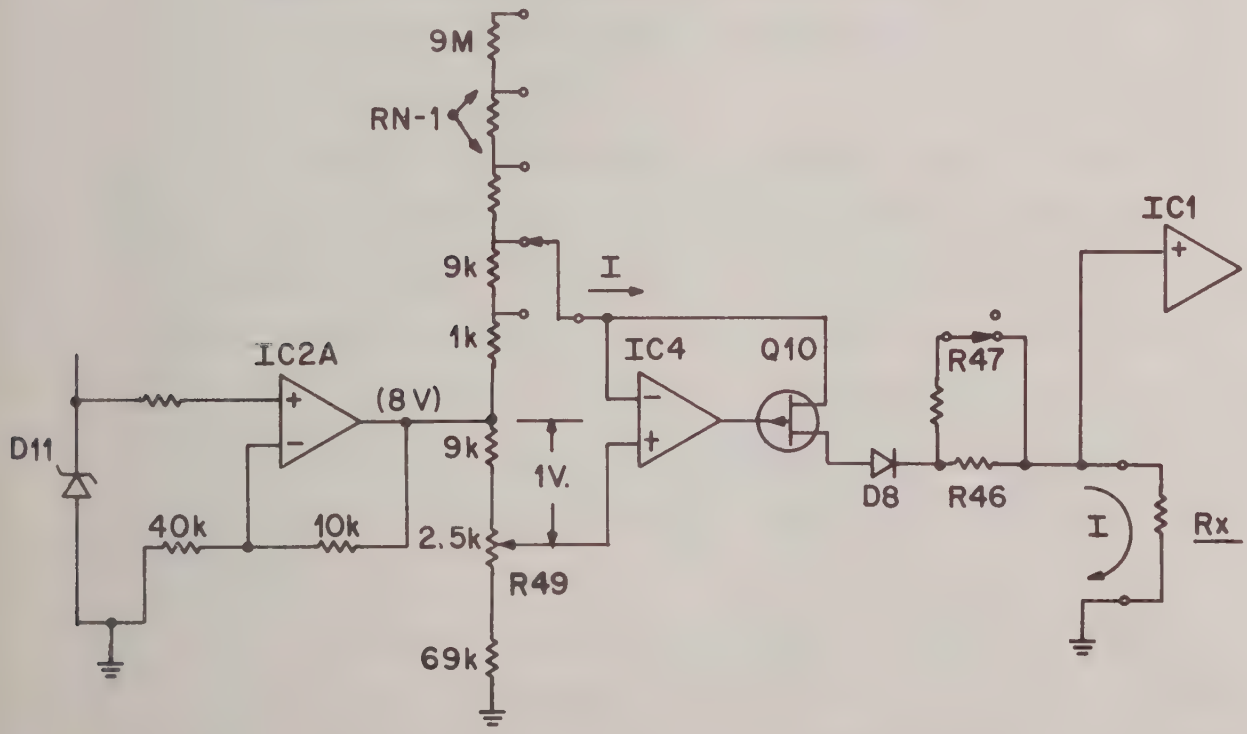



FIGURE 6

not work with an op. amp. that could not swing its output "rail to rail"). Thus, during the positive half-cycle, IC1 is supplying current thru R4 to ground potential thru R3 and R2. During the negative half-cycle, the output of IC4 goes positive, with a gain of 4 to allow for the load of R4, and supplies the current to ground potential thru R2. Tantalum C16 filters the outputs so the voltage across it is 1/2 the DC average of the rectified signal voltage. The current thru R2 charges C13 during the first half of the integration cycle; it goes directly (thru IC8A) to ground during the second half. Note that the schematic symbols "$V_x$" and "$\overline{V_x}$" denote switch-gating voltages from IC6 and IC7C that are complements of each other. The scale factor which makes the average of the rectified signal read as the R.M.S. value is set by the ratio of R1 (RN-4 pin 7) to R2 (pin 9).

6. OHMS CONVERTER (fig. 6)

For resistance measurements, a constant current is generated thru the unknown ($R_X$) and the resultant voltage is applied to voltage follower IC1. For "Low Ω " measurements, the current is divided by 10 and IC1 is switched to a gain of 10 so that 0.1999 volts at the 283 input produces a full-scale reading. Note that the "100 Ω " range acts like a Low Ω measurement even if the Function switch is set to "High Ω ", and "10 MΩ " is only a High Ω Range.

The current is generated by dropping 1 volt thru the selected part of RN-1. IC4 controls Q10, which acts like a variable resistor, to keep its two inputs equal; since its input current is very small and the gate junction of Q10 is reverse-biased, virtually all the current from RN-1 goes thru D8 and Rx.

Series dropping resistor R46 or, in the lower ohms ranges, R47 is used to limit the current that may be drawn by a negative external voltage thru protection diodes Q7 or D7. R47 is a form of thermistor whose resistance increases greatly when heated by power dissipated in it.

7. CURRENT SHUNTS

For current measurements, the input is switched through 0.1, 1, 10, or 100 Ω shunts and the voltage developed is applied to follower IC1 which now has a gain of 10 (full scale output with 0.2 volts in). Diodes D5 and D6 limit the voltage that may be developed between the terminals.

B. DISASSEMBLY

1. Unplug the unit.
2. Remove 2 screws from the back, lift slightly and slide cover forward.
3. Unsolder the red "VOLTS/OHMS" lead from the main P.C. board.
4. Separate the connector in the blue "mA" lead.
5. Remove knobs.
6. Remove 4 screws holding subchassis to case.
7. Carefully slide subchassis back about 3/4 inch and lift it out, watching the leads to the transformer.
8. If PC boards must be removed, first separate the 15-lead inter-board connector then remove display board.
9. Unsolder black wire from underside of fuse holder.
10. Remove main board.

When re-assembling, watch alignment of display board to subchassis or "ZERO" knob may rub on front panel. Do not over-tighten casing screws since the threads in the plastic can be stripped. Note that good electrical contact is needed between the line jack, chassis, and transformer frame to ground the first electrostatic shield.

C. QUICK CHECKS

1. Are display digits lit? If only one is on, do not leave power on for long as digit is being over-driven; 12 kHz clock is probably not running. Check the 3 supply voltages (NOTE: subchassis is ground, lower lead of 43 Ω 2 W resistor is at +12, +5.8 is on R51, -3 is on R201 and may vary - see section A1, above).

2. Is the basic DC Voltmeter function O.K.? Note that "T.P." test point (wire stub near interboard connector) is at voltage of IC1 output in volts and High Ω functions. Plus and minus references may be checked at pots R54 and R55. Check fuse and input connections with short in High Ω function. See section A3 above for check of integrator; if that is improper and everything else so far is all right, check state of the comparator (IC3).

3. Is the ohms function O.K.? If all right in AC volts function (that verifies IC4), check +7 volts at pot R49 then follow current path thru D8 to jacks. Connecting a current meter in place of resistor to be measured checks the current sources (see specs.).

D. CALIBRATION

The procedure listed in the user's manual should be followed exactly with the exception that the following should be used in place of steps 7 and 8:

7. Set FUNCTION to ACV, 1V. range.

8. Apply 0.100 V rms at about 50 or 60 Hz; adjust AC pot (R52) for display of .098.

This provides a slightly more precise setting of the AC zero pot.

## SERVICE - ANALYZER

### ADDENDUM

1. Early main PCB's have a component legend error. 2 capacitors are labeled C15.

   The "C15" near IC4 is in reality C14.

2. Original issue of composite corrections

   A. C14 Part # should be 025-105-9-001

   B. RN-1 Part # should be 012-011-9-001

   C. Schematic value for R217 should be 47 K Ω

3. All analyzing schematics R217 should be 47 K Ω

4. Instruction Manual: Page 5, lines 5,6,7 relative to frequency response over 400 $H_z$ will be deleted in next issue. Unit will not necessarily make these specifications (Response) in this early issue manual text.

   Page 8, line 7 HV 28 should read PR 28.

   Also a carrying case will be available LC-83.

Row 4 Resistance between 1 to

2 0.0 kΩ
3 36.9 kΩ
4 26.5 kΩ
5 25.5 kΩ
6 36.5 kΩ
7 76.7 kΩ
8 19 kΩ
9 [illegible]
10 1660 kΩ
11
12 1760 kΩ
13 0.65 MΩ
14 0.529 MΩ
15 0.5 MΩ
16 0.60 MΩ
17 0.58 MΩ

AT. Re Function

| IC1. | IC4 |
|---|---|
| 1 - 3.68 | 1 + 0.06 |
| 2 - 0.00 | 2 + 0.06 |
| 3 - 0.00 | 3 - 0.00 |
| 4 - 3.77 | 4 - 0.00 |
| 5 - 3.68 | 5 + 0.06 |
| 6 - 0.00 | 6 + 0.32 |
| 7 + 7.93 | 7 + 12.46 |
| 8 + 2.59 | 8 + 10.42 |

AT one Hi Function

| input Point | IC1 | IC4. |
|---|---|---|
| 1 | - 3.89 | + 0.07 |
| 2 | + 0.00 | + 7.30 |
| 3 | - 0.00 | + 7.29 |
| 4 | - 3.98 | - 0.00 |
| 5 | - 3.89 | + 0.07 |
| 6 | - 0.00 | + 8.84 |
| 7 | + 7.93 | + 12.46 |
| 8 | + 2.62 | + 6.38 |

DS

+2.21 — +1.66

No Short

+7.29 6.93

Row - 4. Voltage

| | |
|---|---|
| 1 - 0.00 | 13. - 1.99 |
| 2 - 0.00 | 14 - 0.00 |
| 3 - 0.00 | 15 0.00 |
| 4 - 0.00 | 16 0.00 |
| 5. 0.00 | 17 0.00 |
| 6 - 0.00 | |
| 7 - 0.00 | |
| 8. 0.00 | |
| 9 - 0.00 | |
| 10 + 2.06 | |
| 11 + 2.05 | |
| 12 - 2.00 | |

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